

PATENT COOPERATION TREATY -

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
 US Department of Commerce
 United States Patent and Trademark
 Office, PCT
 2011 South Clark Place Room
 CP2/5C24
 Arlington, VA 22202
 ETATS-UNIS D'AMERIQUE
 in its capacity as elected Office

| | |
|---|---|
| Date of mailing (day/month/year) 30 May 2001 (30.05.01) | |
| International application No. PCT/AU00/01151 | Applicant's or agent's file reference FP12949 |
| International filing date (day/month/year) 21 September 2000 (21.09.00) | Priority date (day/month/year) 21 September 1999 (21.09.99) |
| Applicant STEPANOV, Dmitrii, Yu et al | |

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
 22 March 2001 (22.03.01)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

| | |
|--|--|
| The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35 | Authorized officer Charlotte ENGER Telephone No.: (41-22) 338.83.38 |
|--|--|

A GRATING DESIGNField of the Invention

The present invention relates broadly to a grating structure, method of writing the grating structure and devices incorporating such gratings. The present invention will be described herein with reference to grating structures for non-linear group delay dispersion compensation. However, it will be appreciated that the invention does have broader applications, such as for engineering of phase response of a fibre Bragg grating device.

Background of the Invention

Grating structures are widely used in optical waveguides for example as filters or as compensators for linear group delay dispersion.

In many systems non-linear group delay dispersion, i.e. second and higher order group delay dispersion, plays a significant role. Therefore, it is desirable that a compensator structure be provided that can compensate for non-linear group delay dispersion in such systems.

Summary of the Invention

The present invention provides an optical device incorporating a sampled grating structure having a chirped sampling period.

The optical waveguide may be in the form of an optical fibre.

Alternatively, the optical waveguide may be in the form of a planar waveguide.

The present invention may alternatively be defined as a method of producing a grating structure in a photosensitive optical waveguide, the method comprising the step of irradiating the device with UV light at an intensity sufficient to induce refractive index variations in the waveguide in a manner to produce a sampled grating

- 2 -

structure, and wherein the radiation is controlled in a manner to effect chirping of the sampling period.

The method may further comprise a step of applying an apodisation function during the UV-inducing of the refractive index variations to produce a smooth grating profile. This can help to avoid ripples.

The photosensitive optical waveguide may comprise an optical fibre or a planar optical waveguide.

The invention further provides an optical waveguide incorporating a sampled grating structure a having chirped sampling period.

The invention may alternatively be defined as a method of compensating for group delay dispersion in an optical signal, comprising transmitting the optical signal through a sampled grating structure having a chirped sampling period.

The invention may alternatively be defined as providing a group delay dispersion compensator device comprising a sampled grating structure a having chirped sampling period.

Having made this invention, it has been recognised that a method of producing a zero dispersion WDM channel can be provided, the method comprising the steps of:

- filtering a narrow band optical signal from an input broad band optical signal using a square reflection band filter;
- using a sampled grating structure having a chirped sampling period to compensate for dispersion of the narrow band optical signal in the reflection band filter.

It is noted here that the terms "narrow band" and "broad band" are not intended to be limited to a particular range, but rather to indicate the relative breadth of one when compared with the other.

Further, the present invention provides a device for producing a zero dispersion WDM channel, the device

The Claims Defining the Invention are as Follows:

1. An optical device incorporating a sampled grating structure having a chirped sampling period.
2. An optical waveguide incorporating a sampled grating structure a having chirped sampling period.
3. A group delay dispersion compensator device comprising a sampled grating structure having a chirped sampling period.
4. A device for producing a zero dispersion WDM channel, the device comprising a square reflection band filter for filtering a narrow band optical signal from an input broad band optical signal, and following the optical filter, a sampled grating structure having a chirped sampling period for compensating for dispersion of the narrow band optical signal in the square reflection band filter.
5. A device in accordance with claim 4, comprising a circulator having a plurality of ports, the square reflection band filter being located at one of the ports for filtering the square amplitude narrow band optical signal from the input broad band optical signal entering the circulator at an input port, and the sampled grating structure being located at another port of the circulator to compensate for dispersion in the square band filter, the circulator further comprising an output port for outputting the dispersion-compensated narrow band optical signal.
6. A method of producing a grating structure in a photosensitive optical waveguide, the method comprising the step of irradiating the device with UV light at an intensity sufficient to induce refractive index variations in the waveguide in a manner to produce a sampled grating structure, and wherein the radiation is controlled in a manner to effect chirping of the sampling period.

- 9 -

7. A method of compensating for group delay dispersion in an optical signal, comprising utilising a sampled grating structure having a chirped sampling period.
8. A method of producing a zero dispersion WDM channel, the method comprising:
- filtering a narrow band optical signal from an input broad band optical signal using a square reflection band filter;
 - using a sampled grating structure having a chirped sampling period to compensate for dispersion of the narrow band optical signal in the reflection band filter.

Dated this 21st day of September 2000

The University of Sydney

By their Patent Attorneys

GRIFFITH HACK

INTERNATIONAL SEARCH REPORT

 International application No.
PCT/AU00/01151
A. CLASSIFICATION OF SUBJECT MATTERInt. Cl. ⁷: G02B 5/20, 5/26, 5/28, 6/18, 6/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G02B 5/20, 5/26, 5/28, 6/18, 6/14

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

AU: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

 DWPI and JAPIO with keywords:
 (SAMPL, CHIRP, GRATING, WAVEGUID)
C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|--|-----------------------|
| X | US 5748660 A (DELORME et al) 5 May 1998 Col 1 lines 65-67; fig 1 | 1-3, 7 |
| X | US 5699378 A (LEALMAN et al) 16 December 1997 Col 2 lines 1-38, col 3 line - col 5 line 10; figs 1, 5 | 1-4, 7, 8 |
| X | WO 96/24079 A (THE UNIVERSITY OF SYDNEY) 8 August 1996 Pages 1-9; figs 1-4 | 1-4, 6-8 |

☒ Further documents are listed in the continuation of Box C
 ☒ See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

5 December 2000

Date of mailing of the international search report

13 DEC 2000

Name and mailing address of the ISA/AU

 AUSTRALIAN PATENT OFFICE
 PO BOX 200, WODEN ACT 2606, AUSTRALIA
 E-mail address: pct@ipaustalia.gov.au
 Facsimile No. (02) 6285 3929

Authorized officer

M.E. DIXON
 Telephone No : (02) 6283 2194

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU00/01151

| C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT | | |
|---|--|-----------------------|
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| A | US 5936994 A (HONG et al) 10 August 1999 Figs 1, 5, 7 | 1, 2, 6 |
| A | US 5497393 A (LEE) 5 March 1996 Col 2 lines 25-34; figs 2,3 | |
| A | US 5309260 A (MIZRAHI et al) 3 May 1994 Col 5 lines 22-52 | |

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU00/01151

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

| Patent Document Cited in Search Report | | | | Patent Family Member | | | |
|--|---------|--------|----------|----------------------|----------|----|----------|
| US | 5748660 | DE | 19629916 | FR | 2737353 | GB | 2303739 |
| US | 5699378 | EP | 853831 | WO | 9714201 | | |
| WO | 9624079 | _ AU _ | 45317/96 | CA | 2211834 | EP | 807271 |
| | | US | 6081640 | | | | |
| US | 5936994 | EP | 903820 | JP | 11150339 | | |
| US | 5497393 | JP | 8162710 | | | | |
| US | 5309260 | _ EP _ | 611972 | JP | 6230207 | US | 5625472 |
| | | US | 5993403 | AU | 69159/94 | US | 5366438 |
| | | WO | 9427527 | US | 5588957 | US | 5520619 |
| | | US | 5728054 | AU | 19248/95 | AU | 23821/99 |
| | | CA | 2183959 | EP | 746280 | WO | 9522304 |
| | | US | 6036664 | AU | 63843/96 | EP | 836456 |
| | | WO | 9640018 | | | | |
| END OF ANNEX | | | | | | | |



PATENT COOPERATION TREA

PCT

From the INTERNATIONAL BUREAU

To:

GRIFFITH HACK
GPO Box 4164
Sydney, New South Wales 2001
AUSTRALIE

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

| | | |
|--|--|--|
| Date of mailing (day/month/year) 29 March 2001 (29.03.01) | | |
| Applicant's or agent's file reference FP12949 <i>mep</i> | | IMPORTANT NOTICE |
| International application No. PCT/AU00/01151 | International filing date (day/month/year) 21 September 2000 (21.09.00) | Priority date (day/month/year) 21 September 1999 (21.09.99) |
| Applicant THE UNIVERSITY OF SYDNEY et al | | |

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
AU,KR,US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
CA,EP,JP

The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on 29 March 2001 (29.03.01) under No. WO 01/22126

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a demand for international preliminary examination must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the national phase, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

| | |
|--|---|
| The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. (41-22) 740.14.35 | Authorized officer J. Zahra Telephone No. (41-22) 338.83.38 |
|--|---|

PATENT COOPERATION TREATY
PCT
INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Article 36 and Rule 70)

REC'D 22 JAN 2002

WIPO PCT

6

| | | |
|--|--|--|
| Applicant's or agent's file reference S80127882:MHK | FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416). | |
| International Application No. PCT/AU00/01151 | International Filing Date (<i>day/month/year</i>) 21 September 2000 | Priority Date (<i>day/month/year</i>) 21 September 1999 |
| International Patent Classification (IPC) or national classification and IPC Int. Cl. ⁷ G02B 5/20, 5/26, 5/28, 6/18, 6/14 | | |
| Applicant THE UNIVERSITY OF SYDNEY et al | | |

| | | | | | | | | | | | | | | | | | |
|------|--|---|---|----|-----------------------------------|-----|---|----|---|---|---|----|--|-----|---|------|--|
| 1. | This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36. | | | | | | | | | | | | | | | | |
| 2. | <p>This REPORT consists of a total of 3 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 4 sheet(s).</p> | | | | | | | | | | | | | | | | |
| 3. | <p>This report contains indications relating to the following items:</p> <table border="0"> <tr> <td>I</td> <td><input checked="" type="checkbox"/> Basis of the report</td> </tr> <tr> <td>II</td> <td><input type="checkbox"/> Priority</td> </tr> <tr> <td>III</td> <td><input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</td> </tr> <tr> <td>IV</td> <td><input type="checkbox"/> Lack of unity of invention</td> </tr> <tr> <td>V</td> <td><input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</td> </tr> <tr> <td>VI</td> <td><input type="checkbox"/> Certain documents cited</td> </tr> <tr> <td>VII</td> <td><input type="checkbox"/> Certain defects in the international application</td> </tr> <tr> <td>VIII</td> <td><input type="checkbox"/> Certain observations on the international application</td> </tr> </table> | I | <input checked="" type="checkbox"/> Basis of the report | II | <input type="checkbox"/> Priority | III | <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability | IV | <input type="checkbox"/> Lack of unity of invention | V | <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement | VI | <input type="checkbox"/> Certain documents cited | VII | <input type="checkbox"/> Certain defects in the international application | VIII | <input type="checkbox"/> Certain observations on the international application |
| I | <input checked="" type="checkbox"/> Basis of the report | | | | | | | | | | | | | | | | |
| II | <input type="checkbox"/> Priority | | | | | | | | | | | | | | | | |
| III | <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability | | | | | | | | | | | | | | | | |
| IV | <input type="checkbox"/> Lack of unity of invention | | | | | | | | | | | | | | | | |
| V | <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement | | | | | | | | | | | | | | | | |
| VI | <input type="checkbox"/> Certain documents cited | | | | | | | | | | | | | | | | |
| VII | <input type="checkbox"/> Certain defects in the international application | | | | | | | | | | | | | | | | |
| VIII | <input type="checkbox"/> Certain observations on the international application | | | | | | | | | | | | | | | | |

| | |
|---|---|
| Date of submission of the demand 22 March 2001 | Date of completion of the report 21 December 2001 |
| Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. (02) 6285 3929 | Authorized Officer M.E. DIXON Telephone No. (02) 6283 2194 |

I. Basis of the report

1. With regard to the elements of the international application:*
- ☐ the international application as originally filed.
- ☒ the description, pages 3-7, as originally filed,
page 1, received on 23 October 2001 with the letter of 17 October 2001
page 2, received on 5 December 2001 with the letter of 5 December 2001
- ☒ the claims, pages , as originally filed,
pages , as amended (together with any statement) under Article 19,
page 8, received on 23 October 2001 with the letter of 17 October 2001
page 9, received on 5 December 2001 with the letter of 5 December 2001
- ☒ the drawings, pages 1-14, as originally filed,
pages , filed with the demand,
pages , received on with the letter of
- ☐ the sequence listing part of the description:
pages , as originally filed
pages , filed with the demand
pages , received on with the letter of
2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language which is:
- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).
3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:
- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished
4. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/fig.
5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

| | | |
|-------------------------------|------------|-----|
| Novelty (N) | Claims 1-8 | YES |
| | Claims | NO |
| Inventive step (IS) | Claims 1-8 | YES |
| | Claims | NO |
| Industrial applicability (IA) | Claims 1-8 | YES |
| | Claims | NO |

2. Citations and explanations (Rule 70.7)

The invention is a sampled grating structure having a chirped sampling period and a dispersion characteristic which is substantially proportional to the inverse of a non-linear dispersion function over a selected wavelength range (claims 1-3, 6); as well as compensating for non-linear group delay dispersion in an optical signal utilising a sampled grating having a chirped sampling period (claim 7); and compensating for dispersion of a narrow band optical signal filtered from an input broadband signal using a square reflection band filter and also utilising a sampled grating having a chirped sampling period (claims 4, 5, 8).

While the closest cited art, US 5699378 and WO 96/24079, each disclose a sampled grating structure having a chirped sampling period, they do not disclose the combination of features being claimed.

Therefore the claims meet the requirements of Article 33(2)-(4).